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United States Department of Agriculture,
BUREAU OF ENTOMOLOGY,
L. O. HOWARD, Entomologist and Chief of Bureau.

THE WOOLLY APHIS OF THE APPLE.

(*Schizoneura lanigera* Hausmann.)

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GENERAL APPEARANCE AND METHOD OF WORK.

Throughout the summer on the lower portion of the trunk and particularly on the water sprouts of the apple may often be seen small bluish-white flocculent or cottony patches, which indicate the presence of colonies of one of the worst enemies of the apple, viz, the insect variously known in this country as the "apple-root plant-louse," "woolly apple louse," "woolly aphis," etc., and abroad very generally as the "American blight." It exists in two forms, the one just referred to, above ground on the trunk or water shoots, and another inhabiting the roots and not open to observation. Closely paralleling in these particulars the grape phylloxera, the damage from the woolly aphis is also almost altogether due to the root form, the aerial colonies causing scarcely any injury. On the roots its attacks induce enlargements or galls or swellings very similar to those produced by the phylloxera, and in the cracks of these galls and swellings the root form occurs in clustered masses. The injury to the trees is due both to the sucking up and exhaustion of the vital plant juices and to the poisoning of the parts attacked, as indicated by the consequent abnormal growths.

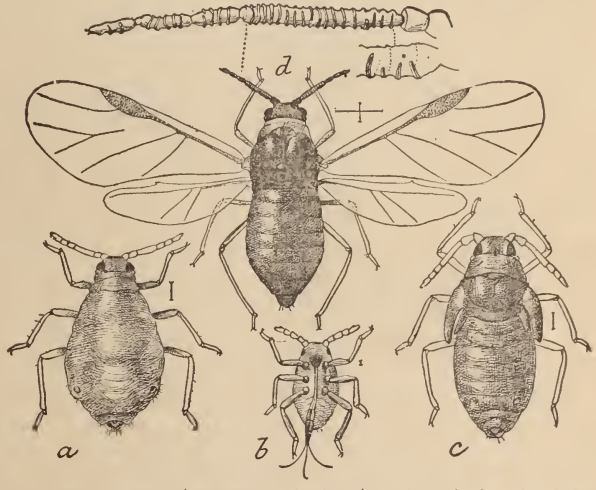

FIG. 1.—Woolly aphis (*Schizoneura lanigera*): *a*, Agamic female; *b*, larval aphis; *c*, pupa; *d*, winged female with antenna enlarged above. All greatly enlarged and with waxy excretion removed. (Original.)

The damage is particularly serious in the case of nursery stock and young trees and is less often important after the tree has once become well established and of some size. Where this insect is abundant all

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the roots of a young tree to the depth of a foot or so become clubbed and knotted by the growth of hard fibrous enlargements, with the result, in a year or two, of the dying of the rootlets and their ultimate decomposition with attendant disappearance of the galls and also of the aphides, so that after this stage is reached, the cause of the injury is often obscure. On the trunks the presence of the aphides sometimes results in the roughening of the bark or a granulated condition which is particularly noticeable about the collar and at the forks of branches or on the fresh growth around the scars caused by pruning, which latter is a favorite location. On the water shoots the insects collect particularly in the axils of the leaves, often eventually causing them to fall, and on the tender greener side of the stems. The damage above ground, though commonly insignificant, is useful as an indication of the probable existence of the aphides on the roots. A badly attacked tree assumes a sickly appearance and does not make satisfactory growth and the leaves become dull and yellowish, and even if not killed outright it is so weakened that it becomes especially subject to the attacks of borers and other insect enemies. Injuries from the woolly aphis are almost altogether confined to the apple, even the wild crab not being so liable to attack or at least injury by it. There is, however, some difference exhibited by different varieties of apple in immunity, and particularly is the Northern Spy proof against it, and it is possible that, as in the case of the grape phylloxera, by employing root stock from seedlings of the more resistant varieties or from wild crabs, considerable protection would result. The character of the soil also exerts some influence—that is, loose dry soils are favorable and wet compact ones are unfavorable to the aphis.

ORIGIN AND DISTRIBUTION.

There is considerable difference of opinion as to the origin of the woolly aphis of the apple. The belief has fluctuated between a European and an American origin for this insect, but the weight of evidence seems to indicate the latter. At any rate, it is an insect which is most readily carried from place to place with nursery stock of the apple, and it has been so transported to practically all the important countries of the world which have been reached by colonization or European settlement. The woolly aphis was first noticed in England in 1787, on some stock imported that year from America, and was early called the American blight. Hausmann described it in 1801 as infesting apple trees in Germany, and within the next twenty-five years it was recognized as a serious enemy of this fruit tree throughout England, Belgium, northern France, and Germany, but seems never to have been especially notable in the warmer latitudes of Europe.

It was very early introduced into Australia and New Zealand, and is known in India and Chile, and probably is as widespread as any of the common injurious fruit pests. Notwithstanding the possibility of its being a native American insect, it did not attract attention in this

country much before 1850. Its spread since has, however, been rapid, and it now occurs practically wherever the apple is grown. It has been reported to this Bureau from no less than thirty-five States and Territories and nearly one hundred localities. It is particularly abundant and injurious in the latitude of the Ohio Valley. While seemingly, therefore, somewhat affected by severe cold, it is able to thrive in the climate of the northern tier of States on the one hand and in that of Louisiana, New Mexico, and southern California on the other.

NATURAL HISTORY AND HABITS.

In common with most aphides, this species has a complicated life history, some of the details of which are still lacking. The common forms, both on the roots and above ground, are wingless aphides, not exceeding one-tenth of an inch in length, and of a reddish-brown color, and abundantly covered, especially in the aerial form, with a flocculent waxy excretion. These are so-called agamic females and reproduce themselves by giving birth, as observed by many entomologists, to living young indefinitely, perhaps for years, without the intervention of other forms. The newly born larvæ have none of the white excretion, which, however, soon appears as a minute down when they begin to feed. These aphides are also peculiar in lacking the honey tubes common to most aphides, but exude the honeydew from the tip of the body. In October or November, or earlier in the South, among the wingless ones numbers of winged individuals appear, which are also all females, and are the parents, as shown by the observations, partly unpublished, of Messrs. Howard and Pergande, of a true sexed generation of minute, wingless, larviform aphides, the females of which, as in the case of the grape root-aphis, give birth to a single "winter egg." This egg is attached within a crevice of the bark, and, probably, following the analogy of the phylloxera, hatches in the spring into a female aphis which originates a new aerial colony.

FIG. 2.—Woolly aphis (*Schizoneura lanigera*): *a*, Root of young tree illustrating deformation; *b*, section of root with aphides clustered over it; *c*, root aphis, female. *a* and *b*, Natural size; *c*, much enlarged. (Original.)

The winged females appear somewhat abundantly in autumn, and are one of the means of the dispersal of the insect. They are very minute,

clear-winged, gnat-like objects, greenish-brown, almost black in color, with the body covered with more or less of the cottony excretion.

The aerial colonies are probably killed out every winter in the colder northern districts, but in the warmer latitudes the partly grown individuals, at least, survive protected in crevices or under bits of bark, and remain more or less active during winter and renew the colonies the following spring. This has been shown to be true in the District of Columbia, and also in the interior regions of the same latitude, in spite of the much colder winters. The root form survives the winter usually in an immature condition, viz, larvæ in various stages of development, and both in latitudes where the aerial forms are killed by the severity of the winter and elsewhere it seems probable that there is a regular upward migration in spring and early summer from the roots, the aerial colonies appearing first near the crown and at a later period on the higher parts of the trees. At any time during the summer and fall there may be migrations to the roots, and throughout the year the subterranean colonies are maintained.

The spread of the insect is accomplished in part by the viviparous females, which appear in late summer, but quite as commonly perhaps by the transporting of young or partly grown individuals from tree to tree or to distant orchards by means of birds or insects to which they have attached themselves. Its wide distribution is usually dependent on the traffic in nursery stock.

REMEDIES AND PREVENTIVES.

The foregoing account of the habits and characteristics of the woolly aphis will enable us to suggest certain measures to control it. The aerial form presents no especial difficulty, and can be very readily exterminated by the use of any of the washes recommended for aphides, such as kerosene emulsion, a strong soap wash, resin wash, etc., the only care necessary being to see that the wash is put on with sufficient force and thoroughness to penetrate the covering and protecting cottony excretion. If the wash be applied warm, its penetration will be considerably increased.

The much more important root form, however, is more difficult to reach and exterminate. Any of the remedies which are applicable to the phylloxera will apply to the apple root-aphis, such as the use of bisulphid of carbon or submersion. The common recommendations are of applications of strong soap or tobacco washes or kerosene emulsion to the soil about the crown, or soot, ashes, or tobacco dust buried about the roots, also similarly employed are lime and gas lime.

The most generally recommended measure hitherto is the use of hot water, and this, while being both simple and inexpensive, is thoroughly effective, as has been demonstrated by practical experience. Water at nearly the boiling point may be applied about the base of young trees

without the slightest danger of injury to the trees, and should be used in sufficient quantity to thoroughly wet the soil to a depth of several inches, as the aphides may penetrate nearly a foot below the surface. To facilitate the wetting of the roots and the extermination of the aphides, as much of the surface soil as possible should be first removed.

Kerosene emulsion, at 20 to 30 per cent of kerosene, has given good results in Georgia, as reported by R. I. Smith.[1]

Mr. J. M. Stedman was the first to demonstrate the protective as well as remedial value of finely ground tobacco dust. The desirability of excluding the aphis altogether from nursery stock is at once apparent, and this Mr. Stedman has shown to be possible by placing tobacco dust freely in the trenches in which the seedlings or grafts are planted and in the orchard excavations for young trees. Nursery stock may be continuously protected by laying each spring a line of the dust in a small furrow on either side of the row and as close as possible to the tree, covering loosely with earth. For large trees, both for protection and the destruction of existing aphides, from 2 to 5 pounds of the dust should be distributed from the crown outward to a distance of 2 feet, first removing the surface soil to a depth of from 4 to 6 inches.

Since its early recommendation marked success has been reported from the use of tobacco dust. A notable instance is that given by Mr. M. B. Waite, of the Bureau of Plant Industry, who applied a ton of tobacco waste, costing $25, in his orchard, with the result of entirely renewing the vigor of his trees and producing a strong stubby growth of twigs. A peck of tobacco dust was placed about each of his larger trees in a circle of 2 or 3 feet around the trunk, and a slightly smaller amount about trees from one to three years old.

The tobacco kills the aphides by leaching through the soil, and acts as a bar for a year or so to reinfestation. The dust is a waste product of tobacco factories and costs about 1 cent per pound, and possesses the additional value of being worth fully its cost as a fertilizer.

The use of bisulphid of carbon for the woolly aphis is the same as for the grape root-aphis. It should be applied in two or three holes about the tree to a depth of 6 to 12 inches and not closer than 1½ feet to the crown. An ounce of the chemical should be introduced into each hole, which should be immediately closed. The bisulphid evaporates and penetrates throughout the soil and readily and promptly kills the aphides. It does not, however, furnish any protection from future attacks, and is attended with danger to the tree unless the precautions named are carefully observed. That it is highly inflammable should also be constantly borne in mind. If it is to be used at all extensively, an automatic injecting device should be secured. The chemical costs about 10 cents per pound in 50-pound cans.

[1] Bul. 60, Bur. Ent., U. S. Dept. Agric., p. 79, 1906.

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Badly infested nursery stock should be destroyed, since it would be worth little even with the aphides removed. Slightly infested stock can be easily freed of the aphides at the time of its removal from the nursery rows. The soil should be dislodged and the roots pruned, and in batches of a dozen or so the roots and lower portion of the trunk should be immersed for a few seconds in water kept at a temperature of 130° to 150° F. A strong soap solution similarly heated or a fifteen times diluted kerosene emulsion will give somewhat greater penetration and be more effective, although the water alone at the temperature named should destroy the insects. This treatment is so simple and inexpensive that it should always be insisted upon by the purchaser if there be any indication of the presence of this insect, and stock exhibiting much damage should be refused altogether.

After planting, if the trees be kept in vigorous growing condition by careful cultivation and, if necessary, proper fertilizing, damage from the aphides is much less apt to occur, and the principal danger period, namely, the first two or three years after planting in the orchard, will pass in safety. The value, as a means of protection, of thorough cultivation and good care of young orchards can not be too strongly insisted upon. Vigorous growing trees have a decided power of resistance and are able to sustain with comparatively little damage the presence of the root-aphides, while illy-cultivated and neglected orchards are especially liable to injury.

The woolly aphis is subject to the attacks of a number of natural enemies, including the parasitic chalcis fly, *Aphelinus mali* Haldemann, and the larva of a syrphus fly, *Pipiza radicum* Walsh and Riley, and also the larva and adult of several species of ladybirds, the larvæ of lace-wing flies, and spiders, etc. In the East a very small brown species of ladybird, *Scymnus cervicalis* Muls., is often present in some numbers, and the common nine-spotted ladybird, *Coccinella 9-notata* Hbst., is also an active enemy of the woolly aphis. The nine-spotted ladybird has been used very successfully in California, on the authority of Mr. Ellwood Cooper, to rid trees of root-aphides, this being effected by colonizing the larvæ of the ladybird at the base of the infested tree. All the parasites mentioned do much to keep the root-aphides in check, and in the case of old well-established trees are in most instances a sufficient protection, but in the case of young trees and nursery stock, where the damage from the aphis is much more rapid and serious, the use of the direct remedies outlined should not be neglected, and particularly should the nursery treatment be insisted upon.

Approved:
JAMES WILSON,
Secretary of Agriculture.

WASHINGTON, D. C., *June 23, 1908.*

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